June-July-August 2003 Rainfall Forecast Interpretation
Central America
March 19th, 2003

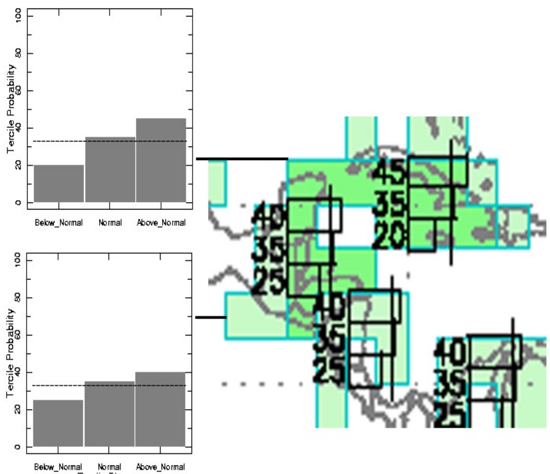

Figure 1. International Research Institute (IRI) June-July-August net assessment precipitation forecast made in February of 2003. Images were obtained from http://iri.columbia.edu/climate/forecast/net_asmt/.

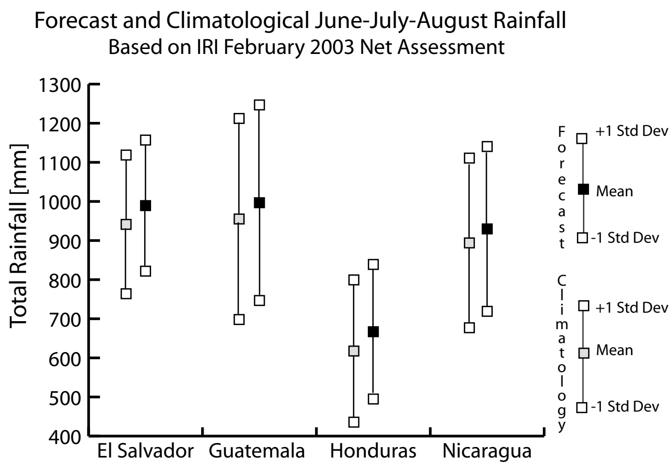

Figure 2. Climatological and forecast rainfall ranges. The climatological average rainfall values, with a +/- 1 standard deviation range, are shown in the left of each country column. The right column shows the average and standard deviation taking into account the IRI forecast. These values were determined by averaging the statistics obtained at 143 individual gauges.

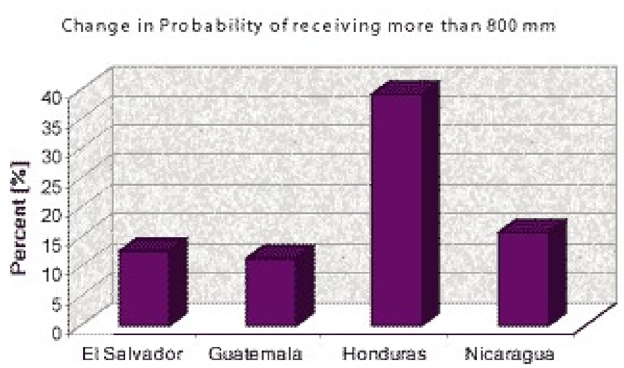

Figure 3. Change in the chance of receiving more than 800 mm of rainfall in June, July and August. Calculated at each station and averaged by country. A value of zero indicates a normal probability for this event. A value of 100 would indicate that the event is twice as likely as in a normal year.

Background

This report presents an interpretation by USGS/FEWS NET[1] of the seasonal precipitation forecast for the main "La Primera" rains (June-July-August) in El Salvador, Guatemala, Honduras, and Nicaragua. The forecast was prepared by the International Research Institute (IRI) for Climate Prediction at Columbia University, one of the world's pre-eminent centers of climate forecasting (http://iri.columbia.edu/climate/forecast/net_asmt/). The IRI forecast was produced in February 2003 by distilling dynamic and statistical model output with expert knowledge of the current state of the climate system. The end result of this process is a probabilistic forecast (Figure 1) of cumulative rainfall in the period June-July-August (JJA). The forecast assigns probabilities to three possible outcomes for 2003: seasonal precipitation totals falling into the lowest third (below normal), middle third (normal), or upper third (above normal) of the historically observed distribution.

Forecast

Under ordinary conditions, there is roughly a 33.3% chance of receiving above normal, normal, or below normal rainfall. The IRI forecast suggests an enhanced probability of above normal rainfall in most of the 4-country region. It calls for a 40% chance of above normal conditions, a 35% chance of normal conditions and a 25% chance of below normal rainfall for western Guatemala, south-eastern Honduras and all of Nicaragua. For El Salvador and western and northern Honduras, the IRI forecast calls for a 45% chance of above normal conditions, 35% chance of normal conditions and 20% chance of below normal rainfall in June-July-August.

These probabilities suggest increases of between 35 and 50 mm of rainfall, corresponding to 5%, 4%, 8%, and 4% increases, respectively, relative to the seasonal mean in El Salvador, Guatemala, Honduras, and Nicaragua (Figure 2). Honduras also shows a substantially greater chance of receiving more than 800 mm of precipitation (a condition of plentiful rainfall) with the probability of this outcome increased by 40%, compared to an increase of about 13% in the other three countries (Figure 3).

Although the IRI forecast is similar for all four countries, the implied anomalies vary quite substantially from region to region (Figure 4). The Pacific coast of Guatemala and El Salvador is likely to have positive anomalies greater than 50 mm. Most of western Honduras is expected to see positive anomalies greater than 40 mm. The northern coast of Honduras has positive anomalies between 20 and 30 mm, as does most of Nicaragua. The probability of getting more than 800 mm of rainfall increased most markedly for Honduras and Southeastern Guatemala (Figure 5) – suggesting that relief from the current drought may be in store.

These forecast interpretation results are experimental. The number of stations and number of historical observations per station are limiting factors, as is the basic uncertainty in any climate forecast. While the outlook appears modestly hopeful for improved conditions, there is still a good chance for below normal rains, and continued drought cannot be ruled out as one possible scenario for the upcoming season.

[1] Prepared by Chris Funk, Diego Pedreros, Greg Husak, Gary Eilerts, Jim Verdin and Jim Rowland.

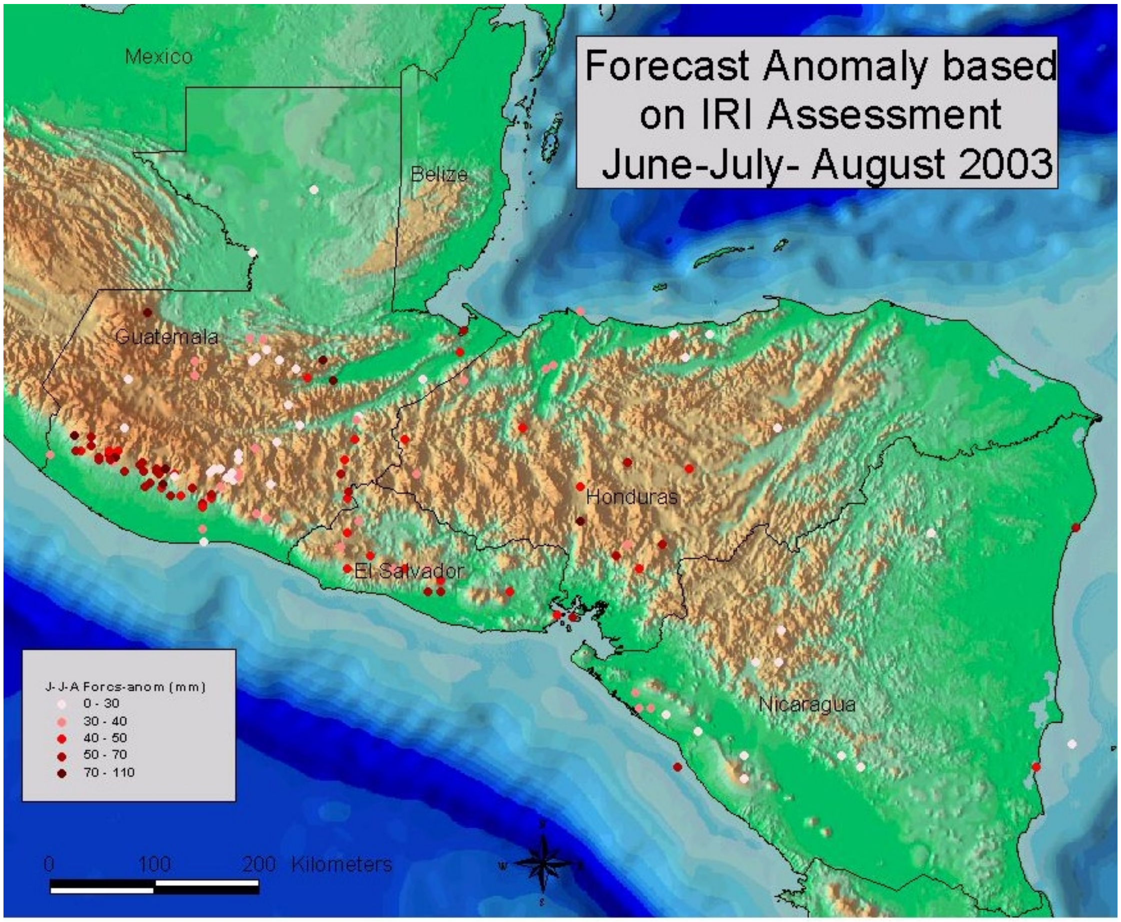

Figure 4. The change in the mean rainfall based on the IRI net assessment forecast.

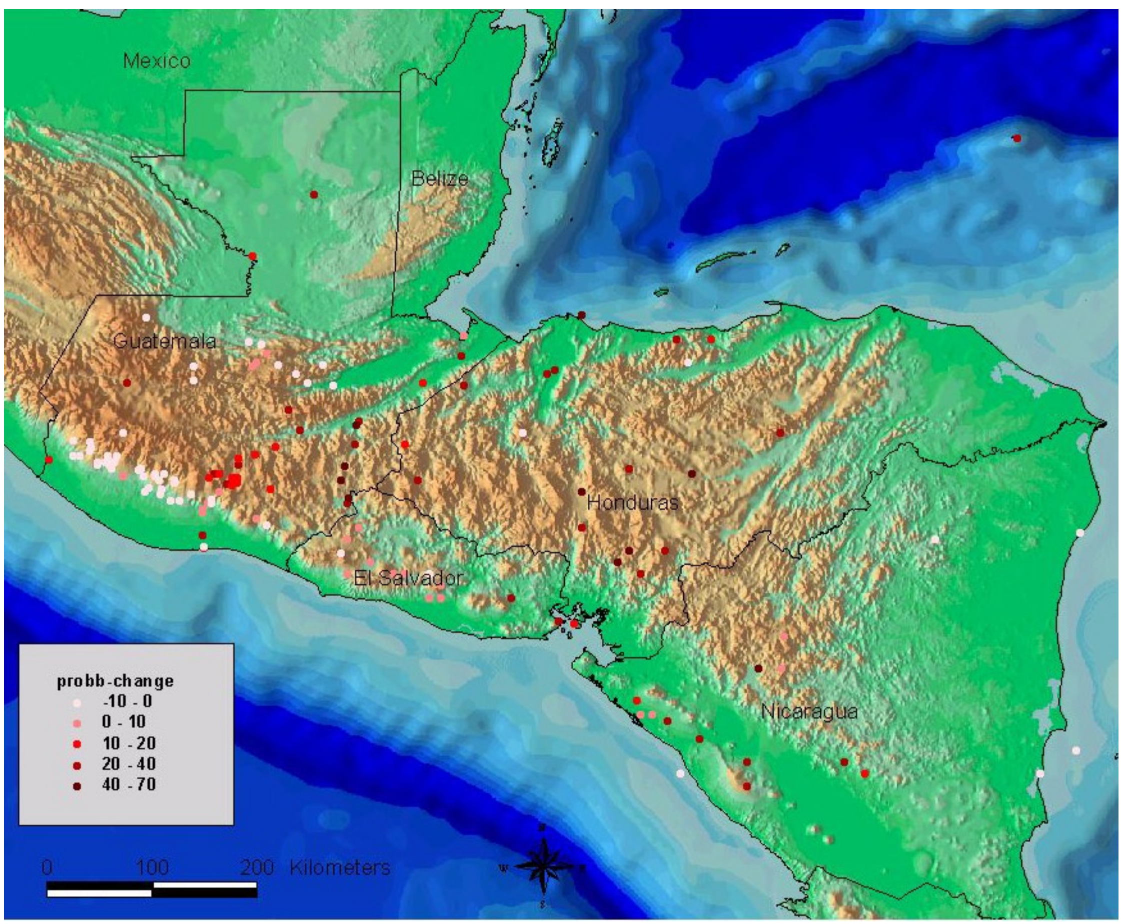

Figure 5. The change in the probability of getting more than 800 mm of rainfall, based on the IRI net assessment forecast. For a value of 0, the probability will not change. For a value of 1 the chance of getting 800 mm of rainfall will double.

Appendix – Technical Details

Data and Methodology

This study was based on historical rain gauge data from the Global Historical Climate Network (GHCN). The GHCN is a strongly quality controlled data set with many observations going back to the turn of the 20th century. This study used years ranging from 1950 to 1999. Only years without missing values in June, July and August were used, and only gauges with at least 15 years of observations were retained. Initially, several different statistical distributions were used to model the time series, and a Kolmogrov-Smirnov (KS) goodness of fit test was used to assess their suitability. The KS test indicated that a normal distribution was appropriate, with 88% of the stations being adequately represented (a=0.95). The 17 non-normal stations were excluded from this analysis, leaving 14 gauges for El Salvador, 88 gauges for Guatemala, 21 stations for Honduras and 18 stations for Nicaragua. The average number of yearly observations for each country was 29, 21, 25 and 20, respectively. Better station data (more stations with more historical observations) would improve these forecast interpretations.

The Forecast Interpretation Tool

The forecast interpretation tool (FIT) provides a method for altering rainfall expectations based on probabilistic forecasts, such as those produced by the IRI and other climate agencies worldwide. The forecast interpretation process assumes that a distribution function has already been fit to each location's historical values, and accurately represents the likelihood of receiving a given rainfall amount in any given year.

With statistical distribution parameters and a probabilistic forecast it is possible to implement the FIT. The FIT can be described in four steps. First the tercile breaks, representing the rainfall values of the 33rd and 67th percentile, are established based on the historical probability distribution function (pdf) calculated at each point (Step 1, Figure 6). Second, values are randomly drawn from each tercile in the proportions described by the forecast map based on the original distribution function (Step 2, Figure 6). Third, the randomly drawn values are then used to calculate new distribution parameters to reflect the proportionately drawn values (Step 3, Figure 6). Finally, by performing the second and third step several times, it is possible to create a distribution of distribution parameters, from which the mean values can be selected to describe the new rainfall distribution function (Step 4, Figure 6).

This new pdf represents a synthesis of historical data and forecast probabilities. Useful statistics, such as the most likely rainfall amount (the mean of a normal distribution) can be derived. The pdf can also be used to describe likely rainfall accumulation ranges, or the likelihood of receiving more or less than a particular critical amount. This updated pdf serves as a transform function relating probabilities and rainfall quantities. For instance, one could find the likelihood of receiving less than 400mm over the season, or conversely one could find the amount of rain corresponding to the 80th percentile (the amount that should be exceeded once in five events). This transform function is very useful for adding value to the probabilistic forecasts.

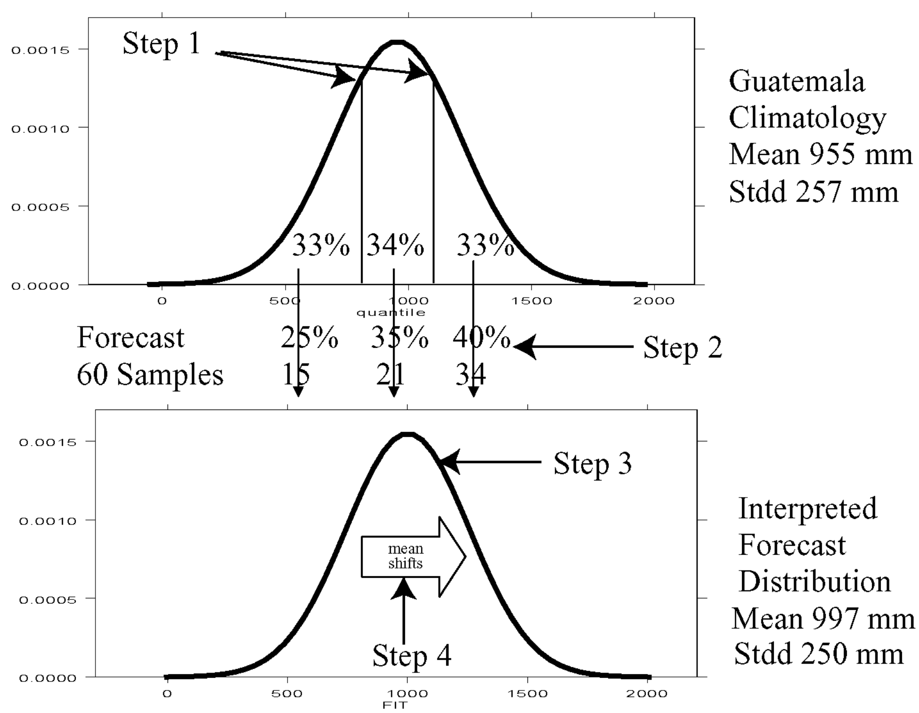

Figure 6. Forecast Interpretation Tool example. Based on average mean and standard deviation for the 88 gauges for Guatemala. Top and bottom panels: probability distribution functions before and after the FIT is applied.

Figure 6 shows an example FIT based on the average results obtained for 88 stations in Guatemala. A distribution with mean of 955 mm and 257 mm is resampled in accordance with the forecast probabilities. If the forecast has a 25%/35%/40% chance of below normal, normal or above normal rainfall, and 60 samples are drawn, then 15, 21, and 34 samples are drawn from the bottom, middle and upper third of the pdf. This corresponds to 0.25x60, 0.35x60 and 0.40x60 observations. The mean and standard deviation of this sample is calculated. This process is repeated many times (not shown) and the means of the newly calculated mean and standard deviation values, respectively, are used to represent the new distribution. This process gives us a new mean and standard deviation for each location, thus combining the spatially coarse (but important) information from the forecast, with spatially fine resolution information provided by the station data.